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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
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1. Your reference — F21521/98P4854/RMK

2. Patent app *(The Patent* — **9823439.6** — 27 OCT 1998

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Roke Manor Research Limited
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Patents ADP number *(if you know it)* — 561545005

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — METHOD OF EXTRACTING A DESIRED SIGNAL

5. Name of your agent *(if you have one)* — Ross M. Kay

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Siemens Group Services Limited
Intellectual Property Department
Siemens House, Oldbury,
Bracknell,
Berkshire, RG12 8FZ

Patents ADP number *(if you know it)* — ~~03899443005~~ 7539273001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

METHOD OF EXTRACTING A DESIRED SIGNAL

The UMTS Terrestrial Radio Access (UTRA) uses Code Division Multiple Access (CDMA) as its multiple access technique. On the uplink (mobile terminal to base station direction), non orthogonal codes are used in combination with power control. Because the codes are not orthogonal, the capacity of the uplink is limited by multiple access interference. The UTRA specification provides for the optional use of short codes to allow the use of various receiver techniques in the base station which rely on the fact that the multiple access interference is not noise but is, in fact, other signals. The receiver techniques which operate in this way are generically known as interference cancellation and joint detection.

One implementation of interference cancellation operates by first demodulating the data on all of the signals directed to the base station. Knowledge of these estimates of the data along with channel estimates allows the generation of delayed approximate replicas of the received signal from each of the mobile terminals. For each wanted signal, the *other* replicas are summed together and subtracted from a delayed version of the received composite signal. Thus, at this stage, the interference has been approximately cancelled for that signal. When demodulation (including despreading) is performed, the BER should be reduced. The whole process can be repeated several times, each time using the improved estimates of the received data to construct the approximate replicas.

One implementation of joint detection operates by treating the sum of the signals as a composite signal having travelled over a path with components relating to the individual signal components. This path is then linearly or non-

linearly equalised in order to permit demodulation of all of the data over all of the signals.

In either of the above approaches it is necessary to have knowledge of the bit rates (and, therefore, the spreading factors) for each of the received signals. In UTRA FDD, the signal format consists of frames of 10 ms duration. there are two channels for each signal: the Dedicated Physical Control Channel (DPCCH) and the Dedicated Physical Data Channel (DPDCH).

The DPCCH is a low power constant bit rate channel. It consists of 16 timeslots each comprising pilot symbols, forward error correction (FEC) encoded transport format indicator (TFI) data and transmit power control (TPC) data. The DPDCH consists of time interleaved, FEC encoded data. It has a bit rate which may vary from one frame to the next, the bit rate of which is carried by the TFI data in the DPCCH of the same frame. On the uplink, in a single spreading code transmission, the DPDCH is first spread to become the in-phase (*I*) channel and the DPCCH is spread to become the quadrature (*Q*) channel. Overall scrambling is then applied to the combined signal.

The TFI data is spread out across the frame and cannot be reliably decoded until the whole of the current frame has been received. Thus the bit rate information, for each of the signals, is unavailable until *the whole of* the current frame has been received. This causes two problems:-

Firstly, the reason for applying interference cancellation or joint detection is to increase the system capacity by allowing the reception of signals at a lower signal to interference ratio than would be possible without using it. This means that before the application of interference cancellation, it may be impossible to demodulate the TFI bits, leading to a deadlock situation. This is true even though the DPCCH and DPDCH are transmitted on nominally

orthogonal (*I* and *Q*) channels since multipath will seriously degrade this orthogonality and because the different signals will be received at the base station with arbitrary mutual carrier phase.

Secondly, power control information is generated by making signal to noise plus interference measurements on the DPCCH *within* the time period of the frame. Thus, if interference cancellation or joint detection cannot be applied until the *end* of the frame, these measurements will need to be based on the signal to noise plus interference *without* the benefit of interference cancellation or joint detection. If the power control measurement threshold is based on an adequate signal to noise plus interference ratio *at this stage* then the resultant signal to noise plus interference ratio *after* the operation of interference cancellation or joint detection will be higher than necessary. On the other hand, attempting to base the power control measurements on there being an adequate signal to noise plus interference ratio *after* the operation of interference cancellation or joint is problematic because: a) the signal to noise plus interference ratio at the measurement stage will be very low – probably too low to measure, and b) it is not possible to predict, a priori, how effective the interference cancellation or joint detection will be in any given slot.

It is proposed in this invention to perform the *first* iteration of interference cancellation or joint detection on the basis that the bit rates for every signal are the same as they were for the same signal in the previous frame. Therefore, according to the present invention, there is provided a method of extracting a desired signal corresponding to a terminal by exploitation of known properties of interference, comprising the steps of: determining a bit rate of a frame of an interfering signal, estimating a subsequent bit rate of an adjacent frame received subsequent to the frame to be

substantially the same as the bit rate of the frame, and manipulating the adjacent frame to assist in the extraction of the desired signal.

Although this may not be true for all of the signals it should be true for the vast majority of signals whenever a large number of signals are present. If the number of active signals is small then the operation of interference cancellation or joint detection will not be needed anyway. If the frame rate is correct, for example, for 90% of signals then, nominally 90% of the interference would be cancellable. The unsuccessful attempt to cancel the remaining 10% of interference would add a further 10%, leaving the interference at 20% in the ideal case. This is a 7 dB reduction in interference – a very useful start.

This approach will allow the interference cancellation or joint detection to be applied slot by slot through the frame, providing its benefits to the demodulation of the TFI data and to the measurements for power control.